SECTION 3

Self-tests

This section describes the *700 Series Ventilator System*'s built-in self-tests, including how to run them. It also describes how the ventilator responds when the self-tests detect undesirable conditions. For a listing of ventilator diagnostic codes, refer to Section 6. For a listing of alarm messages, refer to Section 7.

3.1 Introduction

The *700 Series Ventilator System* has the self-test capabilities described in Table 3-1.

Table 3-1: Self-tests

Name	Purpose	When it is run
Power-on self-test (POST)	Verifies the integrity of the microcontrollers, power supply, battery, transducers, and motor.	Automatically • when power is applied to the ventilator (including after a power interruption) • at the start and end of SST and EST • when exiting from standby mode or calibration • after pressure units are changed (utility menu function) • after the ventilator is reset for any reason
Short self-test (SST)	An abbreviated version of EST to be run primarily by the operator. Makes detailed checks of the pneumatics and electronics. It also characterizes system leaks and system/tubing compliance to compensate during breath delivery. POST is run as part of SST.	Before patient is connected to the ventilator or after ventilator breathing circuit or humidifier is changed
Extended self-test (EST)	Lets a biomedical technician thoroughly test the operational integrity of the ventilator, both the electronics and pneumatics. POST and SST are part of EST.	• When the ventilator is serviced • As part of the ventilator performance verification
	NOTE: The performance verification, described in Section 5, is a more thorough test of the ventilator to verify specifications are met. The technician runs a partial or full performance verification after servicing the ventilator and at regular intervals.	
Ongoing background checks	These checks are performed so as not to disrupt normal operation. Includes these checks: reasonableness of analog inputs, power supply, dc voltages, pressure transducers, and more.	Automatically, continually, during ventilation and a smaller number in the standby mode

3.2 Power-on self-test (POST)

This subsection describes POST, including its operation, routines, and error handling.

3.2.1 Structure of POST

POST diagnoses electronic problems using a minimal amount of system hardware. It is composed of these three sections:

POST1 - Tests the breath delivery (BD) and user interface (UI) microcontrollers and associated circuitry. Each microcontroller runs its own version of POST1. Both versions are practically identical.

POST2 - Consists of tests that are specific to the BD and UI subsystems.

POST3 - Synchronizes both microcontrollers.

Each section of POST is in turn composed of various routines listed in Table 3-2. The tests within POST are generally ordered so that each one requires successively more operational hardware than the last, permitting electronic components to be systematically tested.

3.2.2 Running POST

To run POST, turn on the ventilator power switch. A message is displayed, indicating that POST is running, the ventilator software revision, and the hours of use remaining before preventive maintenance is required. At the end of POST (after approximately 8 seconds), the last valid settings are displayed. The appropriate indicator is lit to indicate the source of power to the ventilator.

During POST, the ventilator's safety valve is opened and the SAFETY VALVE OPEN light is turned on. The safety valve is closed when breath delivery begins.

3.2.3 How the ventilator responds to a POST error

If POST detects an error, it attempts to log the diagnostic code into the test log. In addition, it responds in one of these ways:

- **If the error could be expected to compromise proper ventilation**, a VENT INOP condition is declared. As a result, POST is terminated, and the ventilator is placed into the safety valve open (SVO) state. To clear the VENT INOP condition, you must repair the ventilator and run and pass EST before ventilation can resume. To do so, first cycle power to the ventilator. The ventilator will now let you access a limited set of service menu functions, such as reviewing the test log and running EST (see Section 4).
- **If POST detects (1) a low battery or no battery, (2) low oxygen supply pressure, (3) that a key was pressed while POST was being run due to a soft reset (rather than a power-on), (4) a blocked or missing air intake filter, (5) incorrect tubing connection between P_{cyl} and P_i/P_e transducer, or (6) the safety valve is stuck closed**, it notes the relevant condition, but POST otherwise continues. A technical alert is annunciated after the completion of POST to inform the operator.
- **If other types of errors are detected**, the error is logged and the ventilator resets. If POST still does not pass, the ventilator issues up to two more system resets, waiting for POST to pass, before a VENT INOP condition is declared. As a

result, POST is terminated and the ventilator is placed into the SVO state. To clear the VENT INOP condition, you must repair the ventilator and run and pass EST before ventilation can resume. To do so, first cycle power to the ventilator. The ventilator will now let you access a limited set of service menu functions, such as reviewing the test log and running EST (see Section 4).

- **If POST1 (UI) fails**, the message window displays this message:

  xxxx
  POST running...
  NPB 7x0 S/W Rev x
  PM Due: xxxxx

  where the first line is the diagnostic code.

- If POST1 (BD) or POST2 (BD) fails, the ventilator declares a VENT INOP condition. The ventilator flashes the diagnostic code on the BD section (left side) of the controller PCB in the following sequence:

1. The four LEDs flash the most significant digit (MSD) of the 5-digit error code.
2. All four LEDs flash on and off once.
3. The four LEDs flash the second MSD of the 5-digit error code.
4. All four LEDs flash on and off once.
5. The four LEDs flash the third MSD of the 5-digit error code.
6. All four LEDs flash on and off once.
7. The four LEDs flash the fourth MSD of the 5-digit error code.
8. All four LEDs flash on and off once.
9. The four LEDs flash the least significant digit (LSD) of the 5-digit error code.
10. All four LEDs flash on and off 10 times.

This sequence repeats indefinitely. Each digit is in binary format, with the most significant at the left.

For example, if the LEDs flash in this order (where X = LED on and O = LED off):

O O O O = 0

X O O X = 9

O O O X = 1

O O O O = 0

O X X O = 6

The diagnostic code is 09106. (See Section 6 for complete information on diagnostic codes.)

Table 3-2: POST routines

Section of POST	Description of routine
POST1 (UI and BD)	Microcontroller tests - Test registers and watchdog timers. Initializes microcontroller.
POST1 (UI and BD)	RAM tests
POST1 (UI and BD)	Segment and stack initialization - Initializes kernel memory segments and stacks.
POST1 (UI)	POST retries test - Determines whether POST has started, but failed to complete, three times.
POST1 (UI and BD)	Completion of microcontroller initialization
POST1 (UI and BD)	I/O initialization test - Checks digital I/O read registers to verify that digital I/O was properly initialized by hardware.
POST1 (UI and BD)	I/O initialization - Initializes digital outputs.
POST1 (UI and BD)	User interface initialization - Initializes all UI indicators.
POST1 (UI)	EPROM checksum test
POST1 (UI and BD)	Clock signal test - Verifies frequency of clock signal from other microcontroller.
POST1 (BD)	Motor controller chipset clock test - Verifies frequency of motor controller chipset clock.
POST1 (UI)	DUART test
POST1 (UI and BD)	POST1 completion
POST2 (BD)	Bus monitor test - Verifies that the microcontroller's bus monitor can detect bus error conditions.
POST2 (BD)	Start of piston test - Initializes and checks motor controller chipset, then starts piston movement test to check motor and optoswitches.
POST2 (BD)	Voltage tests - Checks +5 V controller PCB supply voltage and +1.2 V pressure solenoid PCB reference.
POST2 (BD)	BD serial EPROM read - Reads calibration and other transducer constants from serial EPROM on pressure solenoid PCB and writes them to RAM to facilitate later accessing.
POST2 (BD)	EPROM checksum test
POST2 (BD)	Completion of piston test
POST2 (UI)	Number of soft resets test - Checks whether three soft resets have occurred in the past 24 hours of operation.
POST2 (UI)	NVRAM test - Verifies integrity of NVRAM data.
POST2 (UI)	Hardware ID test - Verifies that versions of installed hardware are compatible with version of installed software.

Table 3-2: POST routines (continued)

Section of POST	Description of routine
POST2 (UI)	Voltages test - Checks voltages monitored by the UI.
POST2 (UI)	Temperatures test - Checks temperatures monitored by the UI.
POST2 (UI)	Real-time clock test - Verifies validity (not correctness) of real-time clock's date and time.
POST3 (UI and BD)	POST synchronization - Performs handshaking between UI and BD sections.
POST3 (UI and BD)	POST message exchange - The BD section sends the UI section this information: • BD POST status • Offsets for transducers zeroed by the BD section • Results of BD analog signal tests The UI section sends the BD section this information: • The ventilator model (*740* or *760*) in use • Current operating mode (for example, normal, SST, EST) • Offsets for transducers zeroed by the UI section • Overall status of UI POST • Algorithm constants • Constants stored in NVRAM
POST3 (BD)	Autozeroing of cylinder and exhalation pressure transducers
POST3 (UI)	Zeroing of exhalation flow sensor - Zeroes exhalation flow sensor. Updates the DAC values for the oxygen regulator pressure transducer and the inspiration pressure transducer using the DAC values stored in the serial EPROM the last time the transducers were zeroed.
POST3 (UI)	UI key release test - Is run only if a key was previously held down. Verifies that any key found down was released. If POST was run due to a soft reset, a failure of this test results in a technical alert. If POST was run due to an operator powering on the ventilator, the ventilator waits a maximum of 60 seconds for the operator to release the key. If the key is not released by then, a stuck-key failure is assumed.
POST3 (UI)	Batteries test - Check internal and external battery voltages to determine if the batteries are installed, and if installed, if they are adequately charged.

3.3 Short self-test (SST)

The short self-test (SST) is a subset of the extended self-test (EST), and is primarily for use by the operator. Consult the *Operator's Manual* for information on SST.

NOTE:

- Nellcor Puritan Bennett recommends that the SST be run every 15 days, between patients, and when the ventilator breathing circuit is changed. Nellcor Puritan Bennett recognizes that the protocol for running SST varies widely among healthcare institutions. It is not possible for Nellcor Puritan Bennett to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.
- If SST fails, the *700 Series Ventilator System* lets you keep rerunning SST. To more thoroughly troubleshoot a ventilator that has failed SST, cycle the unit's power while simultaneously holding down the MENU key. The ventilator declares a ventilator inoperative condition, enters a safety valve open state, and allows access to service menu functions. Use these functions to test and troubleshoot the ventilator, as described in Section 4.

3.4 Extended self-test (EST)

This subsection describes the extended self-test (EST), including its hardware requirements, operation, test routines, and error handling. You can run EST from the main or service menus.

NOTE:

Nellcor Puritan Bennett recommends that you always run the full EST before placing the ventilator into operation following service. For preliminary troubleshooting purposes, however, you may want to run EST tests individually by using the *EST tests* function under *Diagnostics/Service, Run tests* (see Section 4.2.3.2.1). The *EST tests* function does not write error information into NVRAM nor declare a VENT INOP condition when tests are failed.

3.4.1 When to run

Run EST before placing the ventilator into operation following service and as part of the ventilator's routine performance verification.

3.4.2 Hardware requirements (Table 3-3)

Table 3-3: Hardware requirements for EST

Description	Manufacturer or model or Nellcor Puritan Bennett part number
Ventilator breathing circuit	To use as test circuit: G-061208-00 or equivalent (adult, reusable, without heated wire) NOTE: To ensure that compliance compensation functions correctly, the user must run EST or SST with the circuit configured as intended for use on the patient.
Stopper, wye (no. 2)	G-061574-00 or local supplier
Stopper, inspiration port (no. 3)	G-061575-00 or local supplier
Oxygen source, 40 to 90 psi (275 to 620 kPa)	Local supplier

Warning

Due to excessive restriction of Air Liquide, Australian, and Dräger hose assemblies, reduced FIO_2 levels may result when oxygen inlet pressures < 50 psi (345 kPa) are employed. Make sure oxygen inlet pressure is approximately 50 psi (345 kPa) when using these hose assemblies, to maintain correct FIO_2 levels.

3.4.3 Running EST

Warning

- Before running EST, you must disconnect the ventilator from the patient. Running EST while the ventilator is connected to the patient can injure the patient.
- A fault identified in EST indicates that the ventilator or an associated component is defective. A defective ventilator or associated component should be repaired before the ventilator is returned to service, unless it can be determined with certainty that the defect cannot create a hazard for the patient, or add to the risks which may arise from other hazards.

Caution

To ensure accurate EST operation, run EST after the ventilator has been powered on for at least 10 minutes.

NOTE:

- During all testing, the pressure LED bar will display the expiratory pressure level. The current pressure is also displayed in the PRESSURE window in the PATIENT DATA section of the keyboard. These displays do not affect the testing but supply additional information when troubleshooting. The exception to this rule is during the piston leak test, when the pressure LED displays the cylinder pressure.
- When EST requires a user response, the ventilator will wait indefinitely.

1. Set up ventilator as for normal operation, complete with humidifier, if applicable, and leak-tight ventilator breathing circuit. You can run EST from the main menu or the service menu.
2. To run EST from the Main menu:
   a. Turn on the ventilator. If ventilation has already begun since the ventilator was turned on, turn off the ventilator and turn it back on without starting ventilation.
   b. Press MENU, turn the knob to select *Self test*, then press ACCEPT. Turn the knob to select *Extended self test*.

   To run EST from the service menu:
   a. Press MENU while simultaneously powering on ventilator. Do not release MENU until prompted by message window.
   b. After POST is completed, press MENU again, turn knob to select ***A. Service menu***, then press ACCEPT.
3. Turn knob to select ***EST***.
4. Respond to the following prompts:

Table 3-4: EST prompts

Message window display	Description
EST	Press ACCEPT to proceed.
Vent warming [*Time countdown*] CLEAR to bypass	This is displayed (followed by a countdown) if you just turned on the ventilator. When 10 minutes have passed since power on, the message is cleared and the ventilator displays the next prompt. NOTE: *It is important that the ventilator be on for 10 minutes before EST is run so that component temperatures can stabilize.* If the ventilator was recently running and is already warmed up, you can press CLEAR to override the **Vent warming** message and begin EST. Nellcor Puritan Bennett cannot guarantee the accuracy of test results in this case, however.
Is pt disconnected?	Confirm that patient is disconnected by pressing ACCEPT; or press CLEAR to return to service menu.
Block wye	Install no. 2 stopper and then press ACCEPT.

Table 3-4: EST prompts (continued)

Message window display	Description
POST running...	Wait a few seconds until POST is completed. NOTE: • If a single beep is not audible during POST, the main audible alarm may be malfunctioning. Troubleshoot as for EST main alarm test (Table 3-9). • During POST it is recommended that you not switch off ventilator power.
humidification device type Choose humidifier	Turn knob to select desired humidification device, then press ACCEPT. Device types include: **HME** (heat-and-moisture exchanger or " artificial nose"), **Dual heated wire** (humidifier with heated wires on both inspiratory and expiratory limbs), or **No heated wire** (humidifier without a heated wire on expiratory limb). Warning Incorrectly specifying the humidifier type during EST can affect the accuracy of spirometry calculations.
tubing type Choose tubing type	Turn knob to select either **Adult tubing** or **Pediatric tubing** and then press ACCEPT. Warning Incorrectly specifying the ventilator breathing circuit type during EST can cause an inappropriate sensitivity for the leak test and occlusion alarm. Nellcor Puritan Bennett recommends using pediatric circuits when ventilating patients with 5 mm or smaller internal-diameter artificial airways. NOTE: To ensure that compliance compensation functions correctly, the user must run EST with the circuit configured as intended for use on the patient.
ET size: x.x mm Choose ET size	Turn knob to select appropriate ET (endotracheal tube) size, and then press ACCEPT. Warning Specifying an ET tube size that is too large can cause premature termination of breaths on very small pediatric patients.

NOTE:
When EST requires a user response, the ventilator will wait indefinitely.

5. The ventilator automatically starts the first test in the sequence (Table 3-8). The tests all run automatically and consecutively, unless a fault occurs. Some tests display additional prompts requiring your response. EST prompts (informational prompts and those requiring your response) are listed in Table 3-6.

   At the end of each test, the test's name and pass/fail/fault status are displayed. If an EST test does not pass, you may still continue EST execution, although the entire EST will not pass until the error conditions are corrected.

NOTE:

It may be useful to complete EST even with errors, because information on multiple errors can facilitate troubleshooting.

Table 3-5: Key functions during EST

Key	Function
ACCEPT	Ignore failure and continue.
CLEAR	Repeat a test or return to prompt at start of a test.
Alarm reset	Retest from beginning of EST (when all tests are completed).
Alarm silence	Stop testing and skip to end of EST.
NOTE: The Alarm silence key is disabled under these conditions: (1) when EST is run as a result of a VENT INOP condition, and (2) (temporarily until the Circuit comp test is complete) if the tubing type or humidifier type you've selected has changed from the previous time EST was run.	
Manual insp	Use to override (when all tests are completed). Can only be used if EST has faulted or testing is incomplete.

Table 3-6: Prompts during EST testing

Prompt	Operator action
Disconnect O2 supply	Disconnect ventilator from oxygen supply. Press ACCEPT.
Reconnect O2 supply	Reconnect ventilator to oxygen supply. Press ACCEPT.
Disconnect I tubing	Disconnect tubing from inspiratory filter outlet. Leave inspiratory filter in place. Press ACCEPT.
I drop =*x x.x* at 100 *or* I drop =*x x.x* at 40 Reconnect I tubing	This is the inspiratory filter pressure drop in cmH_2O at a flow of 100 L/min (adult tubing) or 40 L/min (pediatric tubing). Reconnect tubing to inspiratory filter outlet. Press ACCEPT.
Unblock wye	Remove stopper from patient wye. Press ACCEPT.
Block wye	Insert a stopper into patient wye. Press ACCEPT.
Disconnect E tubing	Disconnect tubing from expiratory filter inlet. Leave expiratory filter in place. Press ACCEPT.
E drop = *x.x* at 100 *or* E drop =*x x.x* at 40 Reconnect E tubing	This is the expiratory filter pressure drop in cmH_2O at a flow of 100 L/min (adult tubing) or 40 L/min (pediatric tubing). Reconnect tubing to expiratory filter outlet. Press ACCEPT.
Block insp filt port	Remove inspiratory filter. Insert no. 3 stopper into inspiratory filter outlet. Press ACCEPT.
Reconnect I tubing	Remove stopper from inspiratory filter outlet. Reinstall inspiratory filter. Press ACCEPT.
Name of a section of display	Press ACCEPT to confirm that all LEDs/LCDs in named section are on.
Upper MDW = blocks?	Press ACCEPT to confirm that all pixels are turned on in upper half.
Lower MDW = blocks?	Press ACCEPT to confirm that all pixels are turned on in lower half.
Name of a key	Press named key.
High alarm sound	Confirm that you hear alarm by pressing ACCEPT.
Medium alarm sound	Confirm that you hear alarm by pressing ACCEPT.
No sound	Confirm that you *do not* hear alarm by pressing ACCEPT.
Is backup alarm ON?	Confirm that you hear alarm by pressing ACCEPT.

6. When the last test in the sequence is complete, the EST completion status is displayed (Table 3-7). Respond as indicated. Service the ventilator, then retest it. If certain tests do not pass, safe ventilation may be compromised, and the ventilator is rendered inoperative until it is repaired. This is called a ventilator *failure*. If certain other tests do not pass, but ventilation might not be compromised (subject to a trained operator's evaluation), this is called a ventilator *fault*. For each EST test, Table 3-8 shows whether its not passing would constitute a failure or fault.

NOTE:

Faults detected during EST may not require the ventilator to be serviced or removed from use immediately. A trained operator, however, must evaluate the situation and determine whether the ventilator can be used. *Failures* detected during EST require immediate servicing and removal of the ventilator from clinical use.

Table 3-7: EST completion status

If the EST result is:	It means:	Do this:
EST passed	All tests were performed and all passed.	**To retest from start of test sequence**, press alarm reset key. **To exit EST and resume ventilation**, press ACCEPT. Unblock the wye as directed, then press ACCEPT. POST now runs, and ventilation resumes at last valid settings.
EST incomplete	All tests passed, but some tests were skipped. The skipped tests were passed on a previous run.	**To retest from the start of the test sequence**, press the alarm reset key. **To exit EST and resume ventilation**, press MANUAL INSP. You are then asked whether you want to use the override feature. Press MANUAL INSP again to complete the override. Unblock the wye as directed, then press ACCEPT. POST now runs, and ventilation resumes at last valid settings.

Table 3-7: EST completion status (continued)

EST fault	One or more tests did not pass. These tests might not compromise the ventilator's ability to ventilate safely, based on the operator's evaluation of the situation.	**To retest from the start of the test sequence**, press the alarm reset key. **To exit EST and resume ventilation**, press MANUAL INSP. You are asked whether you want to use the override feature. Press MANUAL INSP again to complete the override. Unblock the wye as directed, then press ACCEPT. POST now runs, and ventilation resumes at last valid settings.
	Warning Do not use a ventilator that has completed EST with a fault status without verifying its operational integrity by means other than EST and determining that the patient will not be placed at risk.	
EST failed	One or more tests failed that might compromise the ventilator's ability to ventilate safely. A VENT INOP condition is declared when you cycle power to the ventilator.	Repair and retest the ventilator. **To retest from the start of the test sequence**, press the alarm reset key.

Table 3-8: EST tests

No.	Test	Purpose	Status	In SST?	Comments
1	DAC-ADC loop test	A loopback test to check D/A and A/D converters' operation	Failure if not passed	No	
2	Safety valve test	Verifies that safety valve relieves excess circuit pressure	Failure if not passed	Yes	
3	Motor sensor test	Checks operation of rotary encoder	Failure if not passed	No	
			NOTE: To ensure that compliance compensation functions correctly, the user must run EST or SST with the circuit configured as intended for use on the patient.		

Table 3-8: EST tests (continued)

No.	Test	Purpose	Status	In SST?	Comments
4	Zeroing of Po	Zeroes oxygen regulator pressure transducer	Fault if not passed	No	Disconnect and reconnect oxygen supply, as directed. Press ACCEPT to signify you have performed each requested action.
	NOTE: Overriding this fault could result in inaccurate oxygen percentage delivery.				
5	O2 solenoids test	Checks oxygen solenoids and oxygen sensor	Fault if not passed	No	
	NOTE: Overriding this fault could result in inaccurate oxygen percentage delivery.				
6	Flow sensor test	Checks accuracy of exhalation flow sensor	Failure if not passed	Yes, but not identical	
7	Leak test	Checks ventilator breathing circuit for leaks	Fault if not passed	Yes	
	NOTE: Overriding this fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocycling.				
	P_e P_{cyl} compare (part of test 7)	Verifies proper functioning of pressure transducers and ventilator breathing circuit	Fault if not passed	Yes	
	NOTE: Overriding this fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocycling.				
	Auto zero sol test (part of test 7)	Verifies if P_e P_{cyl} auto zero solenoids can be engerized and de-energized.	Failure if not passed	Yes	

Table 3-8: EST tests (continued)

No.	Test	Purpose	Status	In SST?	Comments
8	Circuit comp test	Determines ventilator breathing circuit compliance	Fault if not passed	Yes	
	NOTE: Overriding this fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocycling.				
9	I/E filter test	Checks pressure drop across inspiratory and expiratory limbs of entire patient system. Checks pressure drop across filters.	Fault if not passed	Yes	Mandatory in EST, but optional in SST. Disconnect and reconnect inspiration (I) tube from/to inspiratory filter outlet, and exhalation (E) tube from/to expiratory filter inlet, as directed. Block and unblock wye with a no. 2 stopper, as directed. Press ACCEPT to signify you have performed each requested action.
	NOTE: Overriding this fault could result in inadequate bacteria protection or excessive resistance to inspiration or exhalation.				
10	PEEP system test	Verifies that PEEP system can generate and maintain preset PEEP levels	Failure if not passed	Yes, but not identical	Verifies that PEEP system can generate and maintain preset PEEP levels within either of two sets of limits. If results are within the inner set of limits, test passes the first time. If the results are outside of the outer set of limits, test fails the first time. If the results are outside the inner limits but within the outer limits, the ventilator adjusts its calibration table in nonvolatile RAM (NVRAM) and repeats the test to verify the calibration. The test fails if the calibration cannot be verified after five attempts.
11	Check valve test	Checks check valve outlet port of cylinder	Failure if not passed	No	

Table 3-8: EST tests (continued)

No.	Test	Purpose	Status	In SST?	Comments
12	Piston leak test	Checks piston leak against a table of leak values stored in NVRAM	Failure if not passed	No	First remove inspiratory filter; then block and unblock inspiratory filter port as directed, using no. 3 stopper. Press ACCEPT to signify you have performed each requested action. Replace inspiratory filter at end of test.
13	Lights-displays test	Verifies that lights and displays function	Failure if not passed	No	Observe each named display, and press ACCEPT to verify that it is lit. Press CLEAR if a display is not lit.
14	Keys test	Verifies that every row and column of key matrix can be correctly read	Failure if not passed	No	Press each named key (each key's LED will also be lit). Press CLEAR if a key's LED is not lit.
15	Main alarm test	Checks whether various alarm sounds are audible (at maximum volume)	Failure if not passed	Yes	Listen for each named sound, then press ACCEPT to verify that it is audible. Press CLEAR if a sound is not audible.
16	Backup alarm test	Checks operation of backup alarm circuit	Fault if not passed	Yes	Press ACCEPT if alarm is audible or press CLEAR if alarm is not audible.
	NOTE: Overriding this fault could result in no audible alarm if the main speaker fails.				
17	Fan test	Verifies that main fan is operating correctly by reading fan status bits	Failure if not passed	No	
18	Heaters test	Verifies correct operation of heaters in exhalation system	Fault if not passed	Yes	
	NOTE: Overriding this fault could result in inaccurate monitoring of exhaled volume or damage to the ventilator's flow sensor or exhalation valve.				

3.4.4 Troubleshooting

Refer to Table 3-9 for EST troubleshooting information, including a description of how the ventilator performs each test. These procedures are sequenced to correct the most probable malfunction or to present the most efficient corrective action first. The proposed fixes listed, however, may not always correct the particular problem.

NOTE:

It is recommended that you use the *Sensor data* function (Section 4.2.1) to help confirm the failure of suspect components.

Table 3-9: EST troubleshooting

EST test no.	Test name	How the ventilator performs the test	Corrective action
1	DAC-ADC loop test	Zeroes flow sensor pressure transducer (P_f) and exhalation pressure transducer (P_e). Compares transducer readings (from A/D converter) to expected (autozero DAC) values.	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
2	Safety valve test	Pressurizes system, incrementing by 0.4 cmH_2O every 10 ms, to a maximum of 70 cmH_2O, until safety valve cracks. Compares expected pressure with actual cracking pressure.	1. Check that safety valve/ventilator head harness connection is secure. 2. Check safety valve resistance (10.5 to 14 Ω). 3. Replace safety valve. 4. Replace pressure solenoid PCB.
3	Motor sensor test	Moves piston at 50, 100, and 150 L/min and compares monitored velocities against expected values.	1. Check harness from controller PCB to motor/encoder. 2. Replace motor/encoder. 3. Replace controller PCB. 4. Replace pressure solenoid PCB.
4	Zeroing of Po	Zeroes oxygen pressure transducer in oxygen regulator and reads pressure. Compares pressure reading with calibration value in NVRAM.	1. Make sure oxygen source pressure is between 40 and 90 psi (275 and 620 kPa). 2. Repeat this test and verify that oxygen is disconnected and reconnected when prompted. 3. Check that oxygen regulator pressure transducer/ventilator head harness connection is secure. 4. Recalibrate oxygen regulator pressure transducer. 5. Replace oxygen regulator pressure transducer. 6. Replace pressure solenoid PCB.

Table 3-9: EST troubleshooting (continued)

EST test no.	Test name	How the ventilator performs the test	Corrective action
5	O2 solenoids test	Verifies that O_2 is within 21% ±3% before energizing. Energizes low-flow and high-flow solenoids individually and waits for significant change in FIO_2. Verifies that oxygen sensor reads >25% O_2 (low-flow solenoid) and >50% O_2 (high-flow solenoid).	1. Make sure oxygen source pressure is between 40 and 90 psi (275 and 620 kPa). 2. Check that oxygen regulator assembly/ventilator head harness connection is secure. 3. Use *Review constants* function in service menu to verify that oxygen regulator assembly constants are as stated on calibration label. Input correct constants, as required. 4. Check oxygen solenoid resistances (low-flow--95 to 126 Ω, high-flow--36 to 51 Ω). Replace oxygen regulator assembly, as required. 5. Verify that voltage to solenoids is between +23 to +25 V. 6. Replace oxygen regulator assembly. 7. Replace pressure solenoid PCB.
6	Flow sensor test	Autozeroes flow sensor. Delivers set rate (20, 100, and 150 L/min for adult tubing or 10, 40, and 80 L/min for pediatric tubing). Verifies that exhaled volumes are within ±10% of delivered volumes.	1. Make sure room temperature is not too low. Make sure ventilator has warmed up. 2. Make sure oxygen source pressure is between 40 and 90 psi (275 and 620 kPa). 3. Using *Sensor data* function in service menu, verify that flow sensor transducer temperature (Txdcr) is between 45 and 55°C. Verify correct tubing connections to flow sensor. 4. Use *Review constants* function in service menu to verify that flow sensor constant is as stated on calibration label. Input correct constant, as required.

Table 3-9: EST troubleshooting (continued)

EST test no.	Test name	How the ventilator performs the test	Corrective action
7	Leak test	Pressurizes system to 50 cmH_2O. Ensures that pressure has not dropped below 40 cmH_2O. Monitors exhalation pressure over 6-second period. Verifies that leak is <7 cmH_2O (adult circuit) or <9.5 cmH_2O (pediatric circuit).	1. Verify that tubing setup is correct, that all tubing connections and wye block are secure, and that tubing has no apparent leaks. 2. Verify that inspiratory and expiratory filters are properly installed. 3. Verify that safety valve is closed during this test. 4. Verify that pressure sensing tubes are not leaking. 5. Replace exhalation valve. 6. Replace elbow tube (between inspiration manifold and ventilator outlet). 7. Replace cylinder outlet check valve.
	P_e P_{cyl} compare	Reads cylinder and exhalation pressure transducers. Verifies that readings are within 3.5 cmH_2O of each other.	1. Verify that tubing connections between exhalation and cylinder pressure transducers and their pressure taps are secure. 2. Perform P_eP_{cyl} gain equalization. NOTE: Do not perform the P_e P_{cyl} gain equalization unless the leak test has passed.
	Auto zero solenoid test	During pressurization, turns on the P_{cyl} solenoid ($P_{cyl}1$) and reads the pressure (0 cmH_2O). If the pressure is greater than 6 cmH_2O, the test fails. It turns the solenoid off and reads the pressure again (P_{cyl} 2). The absolute difference between P1 and P2 should be no greater than 20 cmH_2O or the test fails. The P_e test is identical to the one above, except it is perfomed after pressurization and during leak measurement.	1. Verify that the tubing connections between exhalation and cylinder pressure transducers and their pressure taps are secure. 2. Replace autozero valve. 3. Replace pressure solenoid PCB if steps 1 and 2 do not resolve the problem.

Table 3-9: EST troubleshooting (continued)

EST test no.	Test name	How the ventilator performs the test	Corrective action
8	Circuit comp test	Pressurizes system to 10, 40, and 70 cmH_2O (flow of 10 L/min). Measures exhalation pressure, cylinder pressure, and piston position for each pressure, and averages each value at all three positions. Verifies that compliance is between 1 and 12 mL/cmH_2O (adult circuits) or between 1 and 8 cmH_2O (pediatric circuits). If test fault is overridden, compliance defaults to 2.5 mL/cmH_2O (adult circuit) or 1.5 mL/cmH_2O (pediatric circuit).	1. Verify that leak test (test 7) has passed. 2. Verify that tubing setup is correct, that all tubing connections and wye block are secure, and that tubing has no apparent leaks. 3. Verify that both inspiratory and expiratory filters are properly installed. 4. Verify that safety valve is closed during this test.
9	I/E filter test	Establishes flow of 100 L/min (adult circuits) or 40 L/min (pediatric circuits). Makes four separate pressure measurements with limbs disconnected/connected, to determine pressure drops. Verifies that total pressure drop across each limb, including filter, is ≤5 cmH_2O (adult circuits) or ≤3 cmH_2O. Considers an occlusion to have occurred if pressure drop exceeds 80 cmH_2O during test.	1. Make sure operator correctly performed required actions. 2. Replace inspiratory filter. 3. Replace expiratory filter. 4. Check for an occlusion in inspiratory or expiratory limb.
10	PEEP system test	Commands PEEP pump to deliver 5, 10, 15, 20, 25, 30, and 35 cmH_2O. Measures resulting PEEP pressures and verifies that all are within range. Updates calibration table in NVRAM as required (provided measured pressures are in range) and then reruns PEEP system test to verify calibration.	1. Verify that leak test (test 7) has passed. 2. Verify that tubing setup is correct, that all tubing connections and wye block are secure, and that tubing has no apparent leaks. 3. Rerun the test and check that the PEEP pump gradually increases its displacement as the test proceeds. 4. Verify that voltage to PEEP pump is between +23 and +25 V. 5. Recalibrate PEEP pump. 6. Verify that exhalation solenoid tubing connections are secure. 7. Check exhalation solenoid resistance (95 to 126 Ω). Replace solenoid, as required. 8. Replace PEEP pump inlet filter. 9. Replace PEEP pump.

Table 3-9: EST troubleshooting (continued)

EST test no.	Test name	How the ventilator performs the test	Corrective action
11	Check valve test	Establishes flows of 50, 100, and 150 L/min while monitoring cylinder and inspiration pressure transducer readings. Verifies that difference between these two, simultaneous transducer readings < 4 cmH_2O.	Replace cylinder outlet check valve. NOTE: If the monitored oxygen concentration of delivered gas is too low, the outlet or inlet check valve may be stuck open. Apply negative pressure to the wye. If system pressure stays low, check for a stuck check valve.
12	Piston leak test	Advances piston to maintain cylinder pressure of 40 cmH_2O. Verifies that at each calibration position, piston leak is within range of calibrated leak values in NVRAM.	1. Make sure oxygen source pressure is between 40 and 90 psi (275 and 620 kPa). 2. Verify that ventilator outlet port is blocked and not leaking. 3. Perform a leak test using diagnostic EST (*Diagnostics/Calib* function in service menu). 4. Use *Review constants* function in service menu to verify that piston leak constants are as stated on calibration label. Input correct constants, as required. 5. Replace cylinder inlet check valve.
13	Lights-displays test VENTILATOR STATUS indicators VENTILATOR SETTINGS LEDs VENTILATOR SETTING LCDs PATIENT DATA LEDs PATIENT DATA LCDs Message window (LCD panel) upper and lower blocks	Turns on lights and displays and verifies that user reports them *lit*.	1. Verify that LCD panel/UI display PCB connection is secure. 2. Replace LCD panel. 3. Replace UI display PCB. 4. Replace controller PCB.
14	Keys test	Prompts user to press keys and checks for keyswitch closure.	1. Replace keyboard assembly. 2. Replace controller PCB.
15	Main alarm test	Sounds alarm at three volumes and verifies that user reports hearing it.	1. Check speaker resistance (6 to 8 Ω). 2. Check main ventilator head harness continuity. Replace harness, as required. 3. Replace speaker. 4. Replace pressure solenoid PCB.

Table 3-9: EST troubleshooting (continued)

EST test no.	Test name	How the ventilator performs the test	Corrective action
16	Backup alarm test	Sounds piezo alarm and verifies that user reports hearing it.	1. Check main ventilator head harness continuity. Replace harness, as required. 2. Replace speaker. 3. Replace pressure solenoid PCB.
17	Fan test	Checks air flow thermistor reading to determine whether fan is operational.	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and attained a steady-state temperature. 2. Verify that main fan rotates. 3. Check that main fan/ventilator head harness connection is secure. 4. Check that main fan filter is present and clean. Clean or replace as required. 5. Check that air flow thermistor assembly/ ventilator head harness connection is secure. 6. Verify that voltage to fan is between +23 and +25 V. If voltage is present and within range, replace fan. It it is not present or is out of range, replace pressure solenoid PCB.
18	Heaters test	Checks thermistor assembly readings to determine whether heaters are operational.	1. Verify that control thermistor (top) is correctly installed. 2. Verify that heater and thermistor assemblies are securely connected to main ventilator head harness. 3. Replace exhalation heater assembly. 4. Replace exhalation thermistor assembly. 5. Replace pressure solenoid PCB.

3.5 Ongoing checks

Ongoing runtime checks are continually performed during ventilation. If an unexpected condition is detected, a code is logged into the alert log. In addition, the ventilator responds in one of the following ways depending on the type of condition detected. To troubleshoot the ventilator, review the alert log (Section 4.2.4). The diagnostic codes stored in the log are further described in Section 6.

- **Technical alert** - The ventilator has detected an undesirable condition arising from a current or pending malfunction of the ventilator or its supply gas. Examples are battery not charging or ventilator internal temperature too high. The code is logged into the alert log. Ventilation continues, although the ventilator displays a message describing the condition; see Section 7 for a listing of these messages. The audible alarm is sounded and the ALARM or CAUTION light is lit. Some technical alerts are automatically reset if the triggering condition disappears.
- **Software error or hardware error not expected to compromise ventilation** - The ventilator has detected an error while running an ongoing check. The ventilator is reset. The code is logged into the alert log. If more than three such errors are detected within 24 hours, a VENT INOP condition is declared, which results in the ventilator being placed in the SVO state. To clear the VENT INOP condition, you must repair the ventilator and run and pass EST before ventilation can resume. To do so, first cycle power to the ventilator. The ventilator will now let you access a limited set of service menu functions only (see Section 4). Use the *EST* function to run the extended self-test. The results of the EST run, the contents of the test and/or alert log, and other service menu functions will help you determine what to repair. If the error recurs or if multiple errors occur, the problem requires corrective action. Contact your regional Nellcor Puritan Bennett Technical Support.
- **Hardware error that might compromise ventilation** - A VENT INOP condition is declared, which results in the ventilator being placed in the SVO state. The code is logged into the alert log. To clear the VENT INOP condition, you must repair the ventilator and run and pass EST before ventilation can resume, as described above.

SECTION 4

Service and utility functions

Warning

Never perform the service or utility functions while a patient is connected to the ventilator. The ventilator does not provide normal ventilatory support during these functions.

4.1 Introduction

This section describes the *700 Series Ventilator System*'s service and utilities functions, including prompts and expected responses.

4.1.1 Accessing the service or utilities functions

NOTE:

When you cycle power to a ventilator with an active VENT INOP condition, you are given automatic access to a limited set of service menu functions. You must repair the ventilator and run and pass EST before ventilation can resume. Use the *EST* function plus the other service menu functions to test, troubleshoot, and repair the unit.

Access the service or utilities functions as follows:

1. Press the MENU key while simultaneously powering on the ventilator. Do not release the MENU key until prompted by the message window.
2. Press the MENU key again; then turn the knob to locate either **A. Service menu** or **B. Utilities**. Press ACCEPT to select the desired menu.

4.1.2 Summary of functions

Table 4-1 and Table 4-2 summarize the ventilator's *Service* and *Utilities* functions.

Table 4-1: Service functions

Description	Purpose
Sensor data	Primarily for factory use. During ventilation displays monitored parameters, including pressures, temperatures, voltages, battery current, PEEP motor on-time, delivered volume, flow BTPS, and oxygen percentage.
EST	Runs extended self-test (see Section 3 for details on EST).
Diagnostics/Calib	Enables the serial port and up/download (if the Communications option is installed, you can configure serial ports A and B), runs individual EST tests, performs calibrations, erases the contents of the test and alert logs, resets service data, and lets you review and manually update calibration constants.
Review alert log	Lets you read the alert log contents
Test data	Lets you read the test log contents and the EST test results

Table 4-2: Utilities menu functions

Description	Purpose
Pressure format	Lets you choose the unit for display of pressures (cmH_2O or hPa).
Date & time format	Lets you choose the format for display of date (European--with day first, followed by month, or US--with month first, followed by day) and time (12- or 24-hour clock).

4.1.3 Navigating the *Service* and *Utilities* menus

Figure 4-1 shows you how to navigate through all the *Service* and *Utilities* menu functions. In general, the ventilator controls serve these functions:

- The knob lets you locate a function or menu.
- The ACCEPT key selects the function or allows you to proceed to the function's next prompt.
- The CLEAR key returns you to the start of the function or to the previous menu.

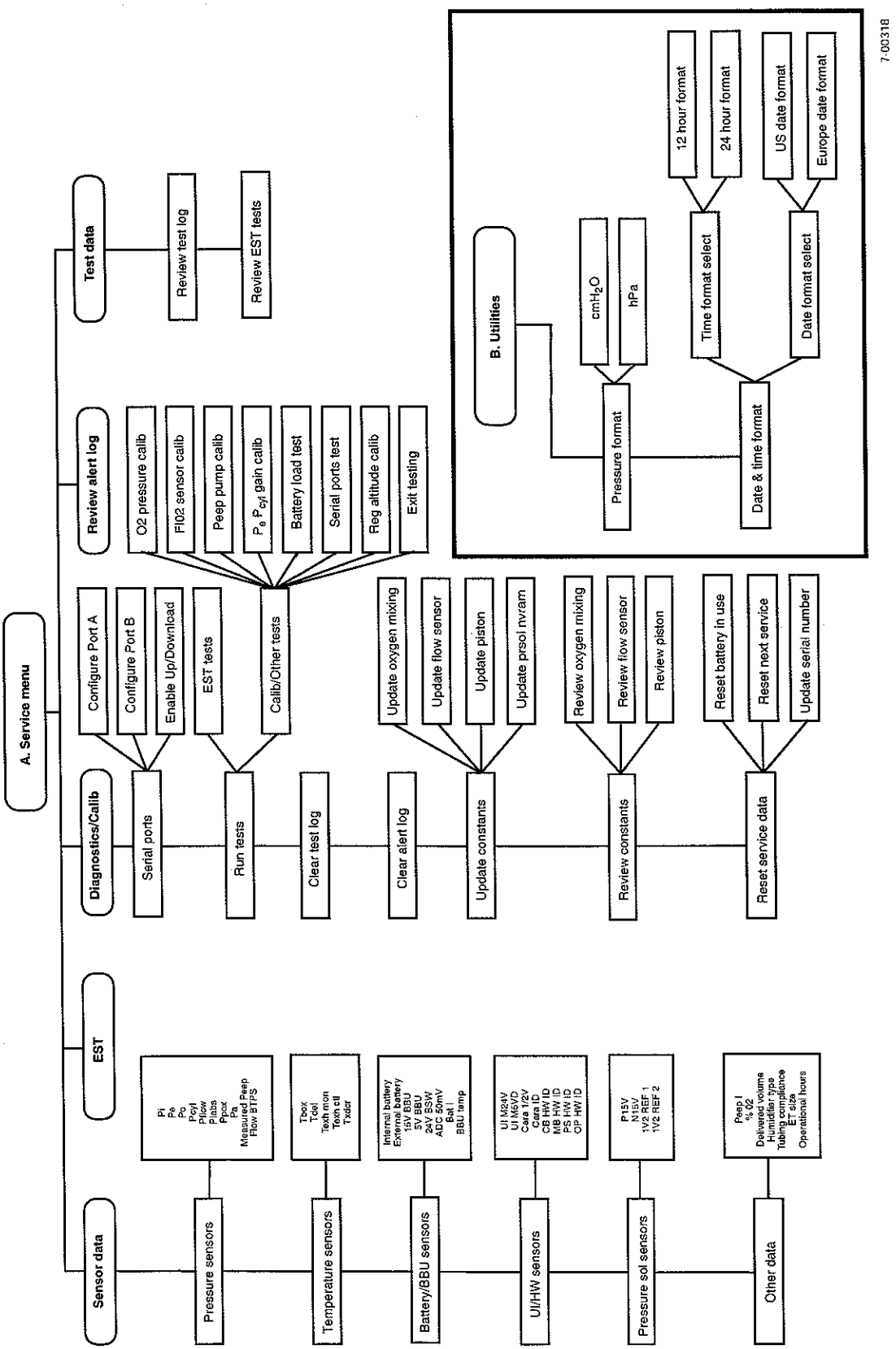

Figure 4-1. Navigating the *Service* and *Utilities* menus

4.1.4 About the test and alert logs and EST test results

The results of ventilator self-tests are stored in NVRAM, as follows:

- Two logs store diagnostic codes corresponding to unexpected conditions detected by the ventilator. Conditions detected during POST, SST, EST, and calibrations (but not the pass/fail status of EST tests) are stored in the *test log*. Technical alerts and other conditions detected during the ventilator's ongoing checks are stored in the *alert log*. Each log holds up to ten codes, corresponding to the ten most recently detected conditions. If the same condition is detected more than once in succession, that code is logged only once, but the number of occurrences is incremented and the time stamp is updated.
- EST test results are stored in NVRAM separately from the test logs. The pass/fail status of the most recent execution of each EST test is stored.

NOTE:

The EST test results stored in NVRAM are always the results from running a full EST. EST tests run individually for diagnostic purposes (**Run tests** under **Diagnostics/Calib**) are not retained in NVRAM.

4.2 Service functions

4.2.1 Sensor data

This function lets you view parameters that are monitored by the ventilator, such as pressures, temperatures, voltages, battery current, PEEP pump current, delivered volumes, flows (BTPS), and oxygen percentage, among others. Sensor data can be viewed at any time while the *Service menu* is active, including while the unit is ventilating; it is the only service function that can be used during ventilation.

To access the *Sensor data* functions from the **A. Service menu** prompt, turn the knob until **Sensor data** is displayed, then press ACCEPT. Now turn the knob to display the desired parameter group. The parameter groups are:

- Pressure sensors
- Temperature sensors
- Battery/BBU sensors
- UI/HW sensors
- Pressure sol sensors
- Other data

When you have selected a parameter group, you will see the following display:

Message window display	Description
name of parameter group (for example, Other data*)*	Turn the knob to locate the desired parameter group; then press ACCEPT.
specific parameter (for example: % O2*)*	Turn the knob to locate the specific parameter desired; then press ACCEPT to view the specific parameter reading (Table 4-3 through Table 4-8). Use the acceptable ranges provided as guidelines in interpreting the readings.
specific parameter sensor reading (for example: % O2 60%*)*	The current reading is updated every 1 second and whenever you press ACCEPT. NOTE: For analog measurements that are converted to digital, the number of A/D converter counts may also be listed in parentheses after the measurement.

Table 4-3: Pressure sensors

Specific parameter	Description	Should read within this range...
Pi*	Inspiration pressure (in cmH_2O)	-40 to 120 cmH_2O
Pe*	Exhalation pressure (in cmH_2O)	-40 to 120 cmH_2O
Po	Oxygen regulator pressure (in cmH_2O)	0 to 2672 cmH_2O
Pcyl*	Cylinder pressure (in cmH_2O)	-40 to 125 cmH_2O
Pflow*	Exhalation flow (in L/min)	-0.5 to 3.5 cmH_2O (each cmH_2O is approximately 135 L/min STPD)
Piabs*	Inspiration pressure transducer (absolute reading) (in cmH_2O)	485 to 1225 cmH_2O
Ppox	Oxygen sensor reading as a partial pressure (in cmH_2O)	Pa x FIO_2 (as a fraction, in cmH_2O)
Pa	Atmospheric pressure (in cmH_2O)	475 to 1155 cmH_2O
Measured Peep*	PEEP measurement (in cmH_2O)	Patient setting ±(0.6 + 10%)
Flow BTPS*	Exhalation flow (BTPS) (in L/min)	Depends on patient's exhaled flow
*Varies with patient settings during ventilation.		

Table 4-4: Temperature sensors

Specific parameter	Description	Should read within this range...
Tbox	Ventilator internal temperature measured on pressure solenoid PCB (in °C)	5 to 70°C
Tdel	Inspiration manifold thermistor reading (in °C)	5 to 70°C
Texh mon	Exhalation system monitor temperature (in °C)	Depends on temperature of delivered gas
Texh ctl	Exhalation system control temperature (in °C)	42 to 75°C (controlled at 50°C nominally)
Txdcr	Temperature at flow sensor transducer (on pressure solenoid PCB) (in °C)	40 to 70°C (controlled at 50°C nominally)

Table 4-5: Battery/BBU sensors

Specific parameter	Description	Should read within this range...
Internal battery	Internal battery voltage reading, taken with charger off (in V)	18 to 30 V. Internal battery reading only available when ventilator is powered by internal battery (otherwise reading is **N/A**).
External battery	External battery voltage reading, taken with charger off (in V)	18 to 30 V (if connected). External battery reading only available when ventilator is powered by external battery (otherwise reading is **N/A**).
15V BBU	Voltage of +15 V line on BBU PCB (in V)	14.2 to 15.8 V
5V BBU	Voltage of +5 V line on BBU PCB (in V)	4.9 to 5.1 V
24V BSW	Input to BBU PCB from power supply (in V)	22.5 to 25.5 V
ADC 50mV	Unused	
Bat I	Battery current (in A)	Charging: 2 A typical (positive reading) Charged: < 0.6 A Battery in use: negative reading
BBU temp	Temperature measured on BBU PCB (in °C)	5 to 70 °C

Table 4-6: UI/HW sensors

Specific parameter	Description	Should read within this range...
UI M24V	+24 V on UI PCB (in V)	19.5 to 30.7 V
UI M5VD	+5 V on UI PCB (in V)	4.7 to 5.4 V
Cara 1/2 V	Ventilator model	740: approx. 0 760: 1023 counts
Cara ID	Unused.	
CB HW ID	Controller PCB hardware revision	Depends on PCB revision
MB HW ID	BBU PCB hardware revision	Depends on PCB revision
PS HW ID	Pressure solenoid PCB hardware revision	Depends on PCB revision
OP HW ID	Reserved for future use	For future use

Table 4-7: Pressure sol sensors

Specific parameter	Description	Should read within this range...
P15V	+15 V measured on pressure solenoid PCB (in V)	14.0 to 15.9 V
N15V	-15 V measured on pressure solenoid PCB (in V)	13.7 to 15.7 V
1V2 REF 1	+1.2 V reference 1 on pressure solenoid PCB (in V)	1.2 to 1.3 V
1V2 REF 2	+1.2 V reference 2 on pressure solenoid PCB (in V)	1.2 to 1.3 V

Table 4-8: Other data

Specific parameter	Description	Should read within this range...
Peep I*	PEEP pump current (in counts)	183 to 818 counts
% O2*	Monitored oxygen percentage	9 to 109%
Delivered volume*	Delivered volume (in mL/min)	40 to 2000 mL
Humidifier type	As specified during SST/EST	HME, Dual heated wire, No heated wire
Tubing compliance	Ventilator breathing circuit compliance determined during the last run of SST/EST (in mL/cmH_2O)	Pediatric or Adult
ET size	As specified during SST/EST	3 to 9 mm
Operational hours	Total hours ventilator has operated	
*Varies with patient settings during ventilation. Can also be read when not ventilating.		

4.2.2 EST (Extended self-test)

This function lets you run the full EST. To access EST from the **A. Service menu** prompt, turn the knob until **EST** is displayed, then press ACCEPT. (You can also access EST from the main menu.)

For a detailed discussion of ventilator testing, refer to Section 3.

4.2.3 Diagnostics/Calib

NOTE:

All service functions can be accessed while the ventilator is not ventilating. When ventilating, the only function accessible is the *sensor data* function.

This function lets you:

- Configure serial ports A and B (if the Communicatons option is installed), and enable up/download.
- Run individual EST tests
- Calibrate the oxygen regulator pressure transducer, oxygen sensor, PEEP pump, equalize the gain of the exhalation pressure transducer/cylinder pressure transducer (P_e/P_{cyl}), run the battery load test, run the serial ports test, and adjust the oxygen regulator for use at high or changing altitudes.
- Exit service mode
- Erase the contents of the test log
- Erase the contents of the alert log
- Manually input calibration constants into NVRAM for the oxygen regulator assembly, the flow sensor, the piston/cylinder assembly, and the pressure solenoid PCB.
- Review calibration constants in NVRAM
- Reset hours of preventive maintenance, battery use, and update serial number.

To access the *Diagnostics/Calib* functions from the **A. Service menu** prompt, turn the knob until **Diagnostics/Calib** is displayed, then press ACCEPT. Then turn the knob to locate the desired *Diagnostics/Calib* function.

Table 4-9 tells you when to perform calibrations or update NVRAM constants.

Table 4-9: Performing calibrations/Updating NVRAM Constants

When this occurs	Do the following
Oxygen sensor replaced	Perform *FIO2 sensor calib* function.
Oxygen regulator pressure transducer replaced	Perform *O2 pressure calib* function.
PEEP pump replaced	Perform *PEEP pump calib* function.
Oxygen solenoid assembly replaced	Perform *Update constants* function.
Flow sensor replaced	Perform *Update constants* function.
Piston/cylinder assembly replaced	Perform *Update constants* function.
Pressure solenoid PCB replaced	Perform *Update prsol nvram*, *FIO2 sensor calib*, and *O2 pressure calib* functions. **Caution** To ensure correct function of the pressure solenoid PCB, be sure to perform the *Update prsol nvram* function *before* the *FIO2 sensor calib* and *O2 pressure calib* functions.
P_e P_{cyl} compare test in EST fails	Perform *Pe Pcyl gain calib* function.

4.2.3.1 Enable serial port

This function lets you enable the serial port to transfer data between the ventilator and a computer. The serial port will remain enabled until the ventilator is powered off. If the ventilator has a communications port, you can either enable the serial port or configure it.

Message window display	Description
Serial ports	Press ACCEPT to proceed.
Configure port A or Configure port B	Press ACCEPT to proceed. Turn knob to change values of B (baud), D (databits), or P (parity) and press ACCEPT to proceed. These settings do not affect the serial port on the controller PCB, whose configuration is set at 19200 Baud, 8 data bits, and no parity.
Enable up/download	Press ACCEPT to enable. Once up/downloading is enabled, you can use one serial port to transfer service data: • serial port A only, if the Communications option is installed. • only the serial port on the controller PCB, if the Communications option is *not* installed. When up/downloading is enabled, normal operation of the Communications panel ports is disabled. The up/downloading function is disabled once ventilator settings are accepted or you turn the ventilator power switch off and back on again.

Settings for some serial devices include:

- Nellcor Puritan Bennett CliniVision *HandHeld* and *VentNet* systems: 9600 Baud, 8 data bits, odd parity.
- Hewlett-Packard Merlin patient monitor: 9600 Baud, 7 data bits, even parity.
- SpaceLabs patient monitor: 9600 Baud, 8 data bits, odd parity.

NOTE:
Settings and other specifications for external devices are subject to change. Consult the external device manufacturer for the most current setting information.

4.2.3.2 Run tests

This function lets you run individual EST tests, perform ventilator calibrations, and other tests. To access *Run tests* functions from the **Diagnostics/Calib** prompt, turn the knob until **Run tests** is displayed, then press ACCEPT. Then turn the knob to locate the desired *Run tests* function.

4.2.3.2.1 EST tests: Running individual EST tests (diagnostic EST)

This function lets you run EST tests individually. It operates almost identically to EST, except that:

- Test results are not written to NVRAM, and
- A test failure does not cause a VENT INOP condition to be declared. Thus, a ventilator that fails an EST test can continue to operate *for troubleshooting purposes only.*
- Pressing ALARM RESET while running diagnostic EST returns you to the start of the full (non-diagnostic) EST.

NOTE:
- Nellcor Puritan Bennett recommends that you always run the full EST before placing the ventilator into operation following service. For preliminary troubleshooting purposes, however, you may want to run EST tests individually. The *EST tests* function does not write error information into NVRAM nor declare a VENT INOP condition when tests are failed.
- This *EST tests* function does *not* substitute for the full EST. After a ventilator is serviced, it must be tested using the full EST before being returned to service.

Message window display	Description
EST tests	Press ACCEPT to proceed. Respond to the prompts, as indicated in Section 3.4.3, until the name of the first EST test is displayed.
name of EST test Run test ? CLEAR (N) ACCEPT (Y)	Press ACCEPT to run this test, or press CLEAR to skip to the next test. If you choose to run the test, the test's pass/fail status is displayed at the end of the test.

Message window display	Description
EST finished testing	Press ACCEPT to proceed.
Unblock wye	Remove stopper from patient wye. Press ACCEPT. The ventilator now runs POST and is ready for ventilation. To return to the service menu, hold down the MENU key while POST is running.

4.2.3.2.2 Calib/Other tests

This function lets you perform various subassembly calibrations or calibration checks and run miscellaneous other tests.

To access the *Calib/Other tests* functions from the **Run tests** prompt, turn the knob until **Calib/Other tests** is displayed, then press ACCEPT. Then turn the knob to locate the desired *Calib/Other tests* function. Upon entry to any of the tests, watch the message display window for prompting.

NOTE:

The *Calib/Other tests* function is different from the *Update constants* function. Use the *Calib/Other tests* function to perform actual calibrations. Use the *Update constants* function to manually input calibration constants into NVRAM. The applicable repair procedures tell you which function to use.

O2 pressure calib: Calibrating the oxygen regulator pressure transducer. This function lets you calibrate the oxygen regulator pressure transducer. It requires a pressure measurement device (for example, the *PTS 2000* or *RT-200*) and an oxygen regulator pressure transducer calibration tool (use tool P/N 4-079050-00 with the *PTS 2000*, or G-061541-00 with the *RT-200*).

Message window display	Description
O2 pressure calib	Press ACCEPT to perform this calibration. NOTE: If you do not wish to perform this calibration, do not proceed, but press CLEAR now. If you press ACCEPT now, the calibration cannot be exited until complete.
O2 pressure calib Connect test gauge	Tee in a pressure measurement device, as shown in Figure 4-3. Press ACCEPT to signify the measurement device is connected. Warning To prevent possible injury, do not remove the dust cap from the oxygen regulator access valve (brass part protruding from the side of the regulator) when the regulator is pressurized. If the access valve is not tightened, the valve may fly off when the dust cap is removed.
O2 pressure calib Disconnect O2 supply	Disconnect oxygen supply from ventilator. Press ACCEPT to signify the disconnection is complete.

Message window display	Description
O2 pressure calib Verify gauge = 0 psi	Verify that the pressure is reading zero (that is, no residual pressure), using the external measurement device. Press ACCEPT to proceed.
O2 pressure calib Reconnect O2 supply	Reconnect oxygen supply to ventilator. Press ACCEPT to signify the connection is complete.
O2 pressure calib Verify gauge >=15psi	This prompt appears if oxygen pressure is below 15 psi. Check that the oxygen supply is reconnected, then use the external measurement device to verify a pressure reading of at least 15 psi. Press ACCEPT to proceed.
O2 pressure calib Enter reg pressure 30.0 psi 2.067 bar	Turn the knob to enter the reading from the pressure measurement device. Press ACCEPT to signify the entered value is correct.
O2 pressure calib Verify reg pressure *xx.x* psi *x.xxx* bar	Press ACCEPT if the value displayed matches the pressure measurement device reading entered above, ±0.2 psi; otherwise, press CLEAR.
O2 pressure calib Disconnect tst gauge	Remove pressure measurement device and **replace cap**. Press ACCEPT.
O2 pressure calib Calibration passed *or* Calibration failed	If the calibration passes, press ACCEPT to return to the *Calibration tests* menu. If you do not intend to perform any other calibration functions, turn the knob to access **Exit testing**; otherwise, turn the knob to access another calibration function. If the calibration fails, try the following corrective actions: 1. Verify that oxygen supply pressure is between 40 and 90 psi (275 and 620 kPa). 2. Repeat this test and verify that oxygen is disconnected and reconnected when prompted. 3. Verify that oxygen regulator pressure transducer is securely connected to main ventilator head harness. 4. Replace oxygen regulator pressure transducer and recalibrate. 5. Replace pressure solenoid PCB. NOTE: If the ventilator was functioning correctly before service, but the calibration fails, it is unlikely that a PCB is malfunctioning.

If you selected **Exit** testing, do the following:

Message window display	Description
Exit testing	Press ACCEPT to reset the ventilator and exit the service menu in preparation for ventilation.

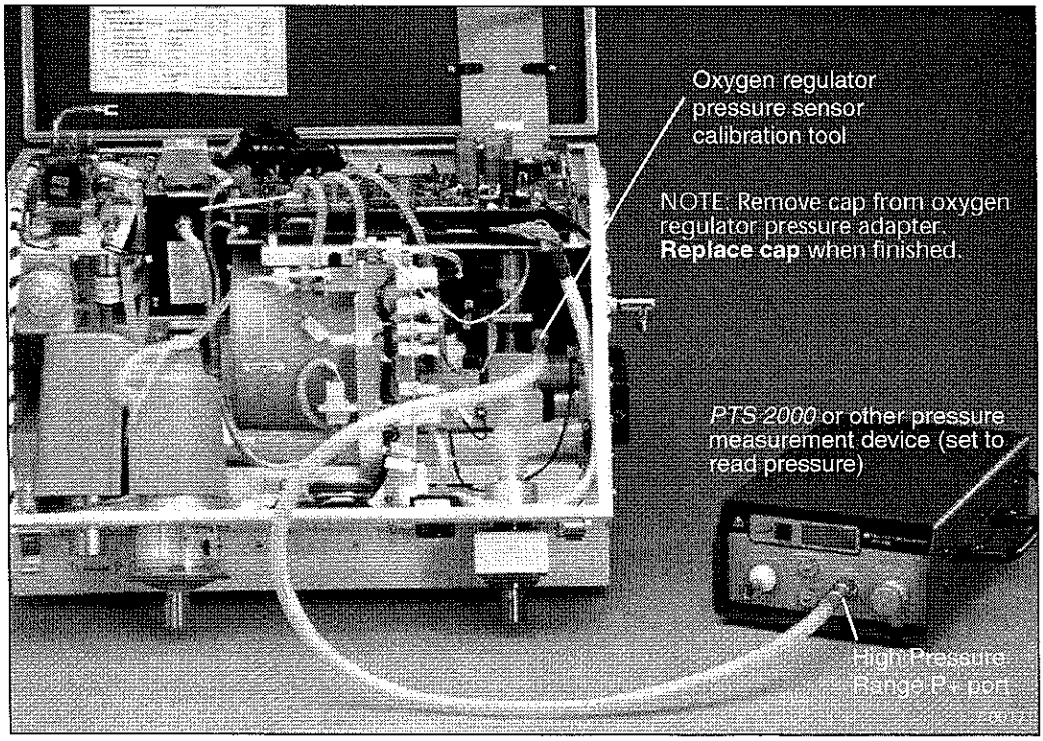
Oxygen regulator pressure sensor calibration tool
NOTE: Remove cap from oxygen regulator pressure adapter. **Replace cap** when finished.
PTS 2000 or other pressure measurement device (set to read pressure)
High Pressure Range P+ port

Figure 4-3. Oxygen regulator pressure transducer calibration setup

FIO_2 sensor calib: Checking the oxygen sensor calibration. This function lets you perform a calibration check of the oxygen sensor. **It requires an oxygen source of at least 50 psi (345 kPa).**

Warning

Never perform the oxygen calibration check in an oxygen-enriched environment. This could result in improper calibration, yielding incorrect oxygen percentage readings.

Message window display	Description
FIO2 sensor calib	Press ACCEPT to perform this calibration check. NOTE: • If you do not wish to perform this calibration check, do not proceed, but press CLEAR now. If you press ACCEPT now, the calibration check cannot be exited until complete. • You can calibrate the oxygen sensor from the service menu (as described here) or the main menu (using the *Oxygen sensor* function).

Message window display	Description
FIO2 sensor calib Please wait...	Wait while the calibration check proceeds.
FIO2 sensor calib Calibration passed *or* Calibration failed	If the calibration passes, press ACCEPT to return to the *Calibration tests* menu. If you do not intend to perform any other calibration functions, turn the knob to access **Exit testing**; otherwise, turn the knob to access another calibration function. If the calibration check fails, try the following corrective actions: 1. Verify that oxygen supply pressure is at least 50 psi (345 kPa). 2. Check harness connections between oxygen sensor and ventilator main head harness. 3. Rerun calibration check. 4. Replace oxygen sensor and repeat calibration check. 5. Replace pressure solenoid PCB.
	NOTE: If the ventilator was functioning correctly before service, but the calibration fails, it is unlikely that a PCB is malfunctioning.

If you selected **Exit** testing, do the following:

Message window display	Description
Exit testing	Press ACCEPT to reset the ventilator and exit the service menu in preparation for ventilation.

Peep pump calib: Calibrating the PEEP pump. This function lets you calibrate the PEEP pump. It requires a PEEP pump calibration tool (P/N G-061540-00).

Message window display	Description
Peep pump calib	Press ACCEPT to perform this calibration. NOTE: If you do not wish to perform this calibration, do not proceed, but press CLEAR now. If you press ACCEPT now, the calibration cannot be exited until complete.
Peep pump calib Connect PEEP tubing to Pe transducer	Make the tubing connections as shown in Figure 4-4. Press ACCEPT to signify you have finished making the connections.
Peep pump calib Please wait...	Wait while the calibration proceeds. Caution The PEEP pump calibration takes approximately 5 minutes and 20 seconds. Touching the PEEP pump armature can cause an incorrect or failed calibration.
Peep pump calib Calibration complete Reconnect tubing	Return the tubing to its normal configuration. Press ACCEPT.
Peep pump calib Calibration passed *or* Calibration failed	If the calibration passes, press ACCEPT to return to the *Calibration tests* menu. If you do not intend to perform any other calibration functions, turn the knob to access **Exit** testing; otherwise, turn the knob to access another calibration function. If the calibration fails, try the following corrective actions: 1. Verify that tubing setup is correct. 2. Verify that voltage to PEEP pump is between +23 and +25 V. 3. Rerun calibration. 4. Verify that PEEP reservoir intake filter is not occluded; replace as required. 5. Replace PEEP pump and repeat calibration.

If you selected **Exit testing**, do the following:

Message window display	Description
Exit testing	Press ACCEPT to reset the ventilator and exit the service menu in preparation for ventilation.

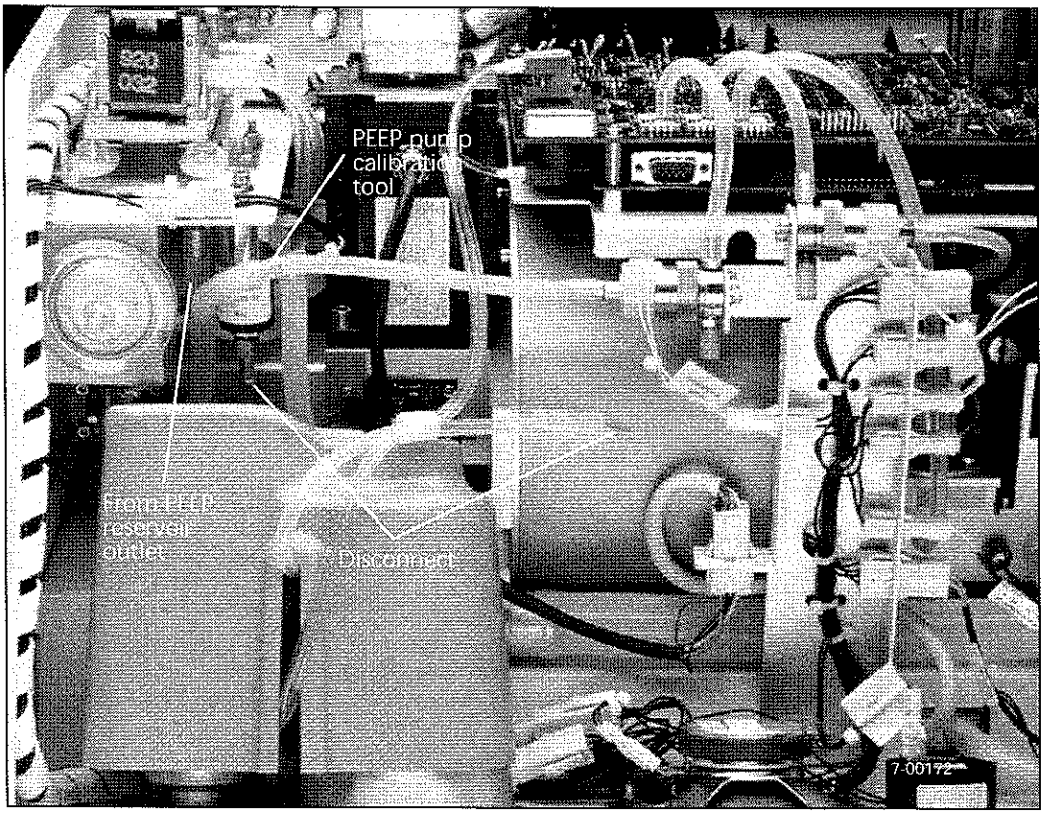

Figure 4-4. PEEP pump calibration setup

P_e P_{cyl} gain calib: Equalizing the gain of the exhalation and cylinder pressure transducers. This function lets you calibrate the exhalation and cylinder pressure transducers. It requires a P_eP_{cyl} kit (P/N G-061557-00).

Message window display	Description
Pe Pcyl gain calib	Press ACCEPT to perform this gain equalization. NOTE: If you do not wish to perform this gain equalization, do not proceed, but press CLEAR now. If you press ACCEPT now, the gain equalization cannot be exited until complete.
Pe Pcyl gain calib Connect syringe	Set up the ventilator, as shown in Figure 4-5. Press ACCEPT to signify you have finished.
Pe Pcyl gain calib Press to 50+/-5cmH2O Meas press= 0 cmH2O	Pressurize the syringe to 50 cmH_2O, as read in the message window and the LED bar graph. Press ACCEPT to signify the measured pressure has reached 50 cmH_2O.

Message window display	Description
Pe Pcyl gain calib Disconnect syringe	Return the tubing to its normal configuration. Press ACCEPT.
Pe Pcyl gain calib Calibration passed *or* Calibration failed	If the calibration passes, press ACCEPT to return to the *Calibration tests* menu. If you do not intend to perform any other calibration functions, turn the knob to access **Exit testing**; otherwise, turn the knob to access another calibration function. If the calibration fails, try the following corrective actions: 1. If the ventilator displays the message **App press too high** or **App press too low**, press ACCEPT to return to the **Calib/Other tests** prompt. Rerun equalization. 2. Verify that test setup is correct. 3. Rerun equalization. 4. Replace pressure solenoid PCB. NOTE: If the ventilator was functioning correctly before service, but the calibration fails, it is unlikely that a PCB is malfunctioning. 5. Replace controller PCB.

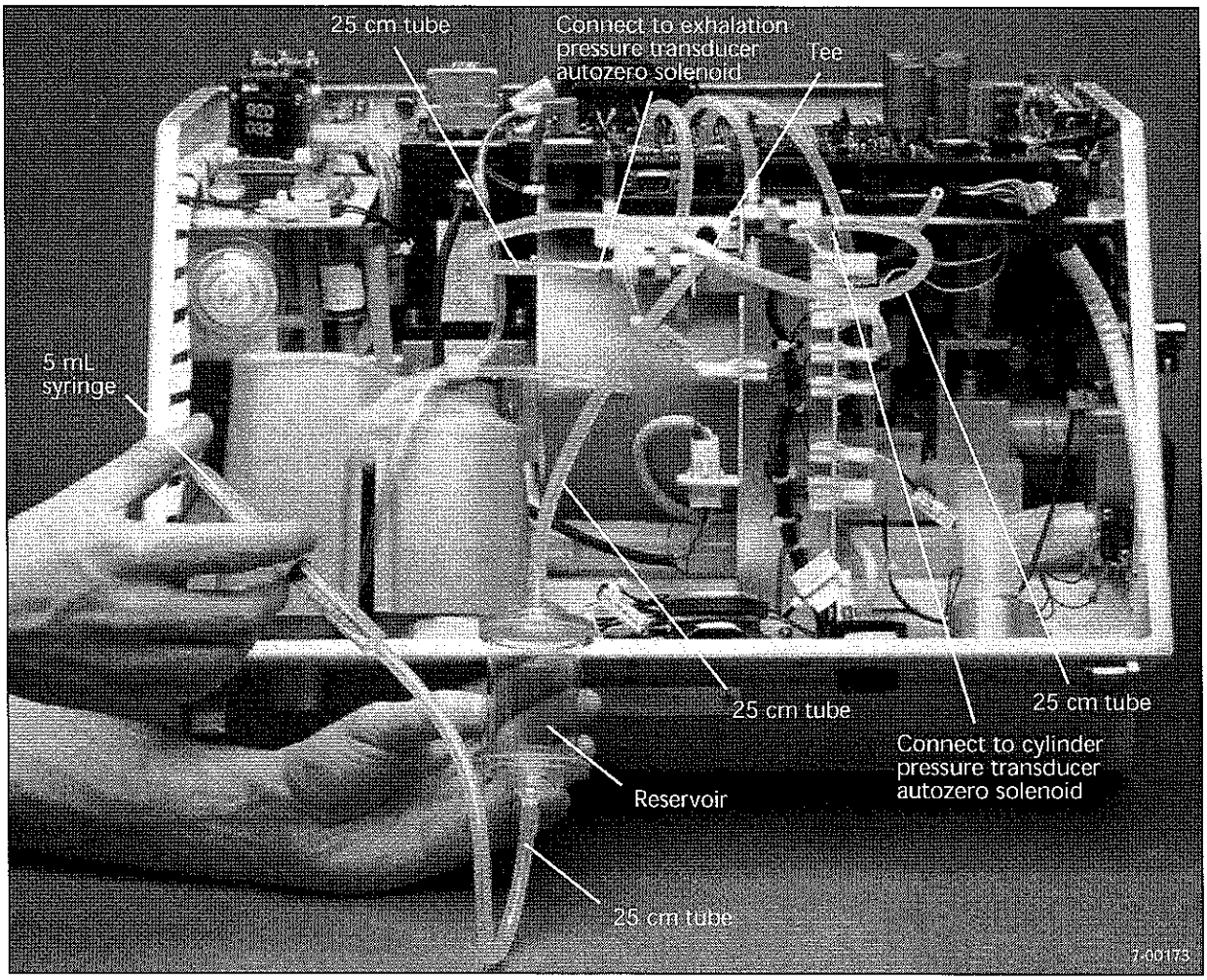

Figure 4-5. P_e P_{cyl} gain equalization setup

Battery load test: This function allows the battery to be tested for at least 20 minutes of power. It requires a no. 3 inspiration port stopper (P/N G-061575-00). The initial voltage should be ≥ 24 V.

Message window display	Description
Battery load test	Press ACCEPT to perform test.
Battery load test Disconnect AC power if connected	Disconnect the ac power. Press ACCEPT. Test fails immediately if AC power remains connected.
Int battery test *or* Ext battery test Block insp filt port ACCEPT to proceed	Ventilator determines which battery is supplying power and lights the appropriate indicator. Block inspiratory filter port. Press ACCEPT to continue.

Message window display	Description
Int battery test *or* Ext battery test xx.x V Please wait...	Displays current voltage, updated every second. Test fails after first piston stroke if inspiratory port remains unblocked. Test continues until complete or voltage drops below limits. (Voltage limits: ≥24 V initially, ≥23 V during first piston stroke, and ≥21 V for remaining nine piston strokes.)
Int battery test *or* Ext battery test Reconnect AC power Reconnect I tubing	Reconnect inspiratory tubing. Verify that AC battery charging indicator string is illuminated when AC is connected.
Battery load test Test passed *or* Test failed ACCEPT to proceed	Press ACCEPT to return to the Calib/Other tests menu.

Serial ports test: This function allows you to test the functionality of the serial communications hardware (if present).

Message window display	Description
Serial ports ACCEPT to proceed	Press ACCEPT to perform test.
Connect port A to B	Connect the ports.
Serial ports test Test passed ACCEPT to proceed	Press ACCEPT to complete the test.
If serial communications NOT present: Serial ports test Are ports present? Clear (N) Accept (Y)	Press CLEAR to pass test, then press ACCEPT to complete the test.

Reg altitude calib: Adjusting the oxygen regulator for use at high or changing altitudes. This function adjusts the oxygen regulator pressure to achieve the lowest allowable oxygen mixing flow from the high-flow solenoid, which reduces noise from the high-flow solenoid during oxygen mixing. Perform this adjustment if:

- The ventilator is to be used at altitudes of 1,000 meters (3300 feet) or higher (atmospheric pressure of 915 cmH_2O or lower). Failure to perform this adjustment when relocating from lower to higher altitudes may result in excessively noisy ventilator operation but does not affect performance.
- The ventilator was previously adjusted for high-altitude operation and is now to be used an altitude that is lower by 500 meters (1600 feet) or more (an atmospheric pressure increase of 50 cmH_2O or more). Failure to perform this adjustment when relocating from higher to lower altitudes may result in inadequate oxygen supply pressure and one or both of these alarms: **LOW O2 SUPPLY, O2% LOW.**

NOTE:

To display atmospheric pressure (Pa), enter the Service menu, then press ACCEPT to select each of the following functions:

Sensor data
Pressure sensors
Pa

Caution

To help avoid triggering **LOW O2 SUPPLY** or **O2% LOW** alarms, perform the Reg altitude calib using the lowest oxygen supply pressure and most restrictive oxygen hose and adapters that will be used during normal ventilation.

To avoid the possibility of entering a ventilator inoperative condition or damaging the regulator, do not power down the ventilator during this adjustment. However, in case of power loss to the ventilator during adjustment, follow these steps:

- Use a pressure gauge to ensure that regulator pressure is below 38 psi (the ventilator will not pass POST if regulator pressure is above 38 psi).
- At power-up, support the oxygen regulator to prevent the piston rack from hitting the regulator.
- Once ventilator power is restored, perform the entire Reg altitude calib.
- Replace the inspiratory access panel at the end of the adjustment to support the oxygen regulator.

You need a 3/16-in. open or box-end wrench, a 3/8-in. open or box-end wrench, and #1 and #2 POZIDRIV screwdrivers to perform this adjustment.

Message window display	Description
Reg altitude calib	Press ACCEPT to begin this adjustment.
Reg altitude calib Is Po calibrated? CLEAR (N) ACCEPT (Y)	Press ACCEPT if you performed an O2 pressure calib during this service session, or press CLEAR if you have not yet performed an O2 pressure calib. If you press ACCEPT, there is a one-second burst from the high-flow solenoid.
Reg altitude calib Perform Po calib ACCEPT to proceed	If you pressed CLEAR at the previous prompt to indicate that you have not yet performed an O2 pressure calib during this service session, this message appears to tell you to perform that adjustment first. Press ACCEPT to exit the Reg altitude calib, then turn the knob to select *O2 pressure calib*.
Reg altitude calib Excessive Po droop ACCEPT to proceed	This prompt appears following the one-second high-flow solenoid burst if there is an oxygen supply problem (oxygen regulator pressure dropped below 4 psi during the burst), such as a disconnected or restricted supply or inadequate supply pressure. Press ACCEPT to exit the Reg altitude calib, then resolve the oxygen supply problem.
High Flow=xxx L/min Calib not required Po=xx.x psi	This prompt appears if the Reg altitude calib is not required, and indicates that the flow from the high-flow solenoid already set properly, and that the adjustment is not required. (*High Flow* is the measured flow during the test burst, and *Po* is the oxygen regulator pressure.) Press ACCEPT to exit the Reg altitude calib.
High Flow=xxx L/min Remove insp panel ACCEPT to proceed	This prompt appears following the one-second high-flow solenoid burst if the Reg altitude calib is required. Remove the inspiration access panel and air intake manifold assembly (Section 8.6.6) to access the oxygen regulator. (Leave the oxygen regulator in place, supported by the nozzles.) Press ACCEPT to continue or CLEAR to abort the adjustment.
High Flow=xxx L/min Calibration aborted	If you pressed CLEAR at the previous prompt to indicate that you want to abort the Reg altitude calib, this message appears. Press ACCEPT to exit the adjustment.
High Flow=xxx L/min Adjust to xx.x psi Po=xx.x psi	When you see this message, turn the 3/8-in. wrench counterclockwise to loosen the lock nut at the top of the oxygen regulator, then use the 3/16-in. wrench to turn the adjustment screw at the top of the regulator and adjust regulator pressure to the displayed value as shown in Figure 4-6 (turning the screw counterclockwise reduces pressure). The message *Po=xx.x psi* shows the real-time regulator presure as you make this adjustment. Press ACCEPT once you have adjusted regulator pressure.
High Flow=xxx L/min Reg pres unchanged ACCEPT to proceed	This message indicates that oxygen regulator pressure remained within 0.2 psi of the initial pressure (that is, that regulator pressure was not adjusted). Use the 3/8-in. wrench to re-tighten the lock nut at the top of the oxygen regulator. Press ACCEPT to exit the adjustment.

Message window display	Description
High Flow=xxx L/min Default pressure set Replace insp panel	This message indicates that regulator pressure has been reset to the factory default value of 33 ± 2 psi. Use the 3/8-in. wrench to re-tighten the lock nut at the top of the oxygen regulator. Replace the inspiratory access panel, then press ACCEPT to exit the adjustment.
High Flow=xxx L/min Calibration passed Replace insp panel	This message indicates that the Reg altitude calib was successful. Use the 3/8-in. wrench to re-tighten the lock nut at the top of the oxygen regulator. Replace the inspiratory access panel, then press ACCEPT to exit the adjustment. If the calibration passes, press ACCEPT to return to the *Calibration tests* menu. If you do not intend to perform any other calibration functions, turn the knob to access **Exit testing**; otherwise, turn the knob to access another calibration function.

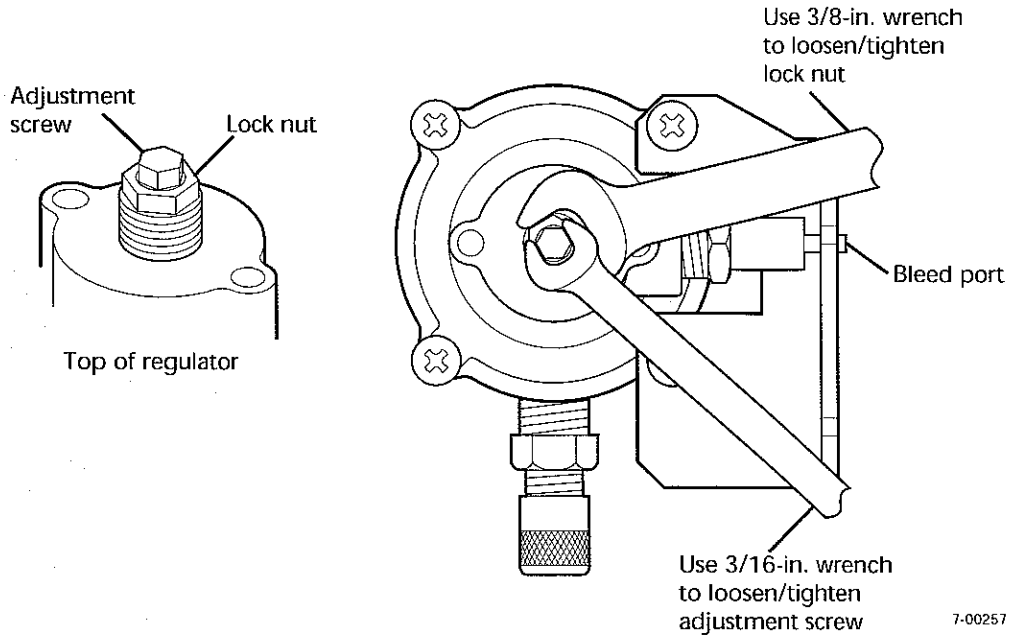

Figure 4-6. Adjusting oxygen regulator pressure

If you selected **Exit** testing, do the following:

Message window display	Description
Exit testing	Press ACCEPT to reset the ventilator and exit the service menu in preparation for ventilation

4.2.3.3 Clear test log: Erasing the test log

This function lets you erase all diagnostic codes from the test log.

Message window display	Description
Clear test log	Press ACCEPT to erase all diagnostic codes from the test log.
Clear test log Log cleared	Press ACCEPT.

4.2.3.4 Clear alert log: Erasing the alert log

This function lets you erase all diagnostic codes from the alert log.

Message window display	Description
Clear alert log	Press ACCEPT to erase all diagnostic codes from the alert log.
Clear alert log Log cleared	Press ACCEPT.

4.2.3.5 Update constants: Manually inputting calibration constants into NVRAM.

This function lets you manually input calibration constants into NVRAM. It is intended for use when installing a new oxygen solenoid assembly, flow sensor, or piston/cylinder assembly.

NOTE:

Always set the calibration constants to the values listed on the calibration constants label for the applicable part.

Message window display	Description
Update constants	Press ACCEPT to proceed.
Update oxygen mixing *or* Update flow sensor *or* Update piston *or* Update prsol nvram	Turn the knob to locate the desired category of calibration constant and select by pressing ACCEPT. **Caution** To ensure correct function of the pressure solenoid PCB, if you perform the Update prsol nvram function, you must then perform the **O2 pressure calib** and **FIO2 sensor calib** functions.

Message window display	Description
specific calibration constant *value of constant* Turn knob to adjust	Turn the knob to adjust the constant's value. For all constants (except piston leak constants), the adjustment is a two-step process. First, use the knob to perform a coarse adjustment (that is, to adjust the hundreds or the whole number, in the case of a decimal number). Press ACCEPT when this coarse adjustment is complete. Then use the knob to perform a fine adjustment (that is, to adjust the ones or the decimal part of the number). Press ACCEPT when this fine adjustment is complete. NOTE: If you need to perform only the fine adjustment, you must still press ACCEPT to proceed to the fine adjustment.
Update new constants Are you sure? CLEAR (N) ACCEPT (Y)	Press ACCEPT to write the new constants to NVRAM. If applicable, be sure to affix the small calibration constants label for the new part atop the larger calibration constants label on the lid.
Cycle power then perform FIO2 calib and O2 press calib	This prompt appears at thend of the **Update prsol nvram** update, and indicates that you should turn the ventilator off, then back on, and perform **FIO2 calib** and **O2 press calib** (Section 4.2.3.2.2).

4.2.3.6 Review constants: Viewing calibration constants in NVRAM

This function lets you view calibration constants in NVRAM.

Message window display	Description
Review constants	Press ACCEPT to proceed.
Review oxygen mixing *or* Review flow sensor *or* Review piston	Turn the knob to locate the desired category of calibration constant and select by pressing ACCEPT.
specific calibration constant *value of constant* Press CLEAR to exit	Turn the knob to view the value of each calibration constant in this category. Press ACCEPT or CLEAR to return to the previous (**Review...**) prompt.

4.2.3.7 Reset service data

When you install a new internal battery, this function resets that part's life expectancy value, which is stored in NVRAM. When you perform a regularly scheduled service, this function lets you change the number of hours until the next service, which is also stored in NVRAM. The ventilator uses these new values to

update the ventilator's Service summary display (function 10). This function also allows you to update the ventilator serial number.

Message window display	Description
Reset service data	Press ACCEPT to proceed.
Reset battery in use *or* Reset next service *or* Reset serial number	Turn the knob as required to locate the desired type of service data. Press ACCEPT to select it.

If you selected **Reset battery in use**, you will see this display:

Message window display	Description
Reset battery in use *or* Are you sure? CLEAR (N) ACCEPT (Y)	Press ACCEPT to reset the hours of *internal* battery life.

If you selected **Reset next service**, you will see this display:

Message window display	Description
xxxxx hours	Turn the knob to adjust the number of hours until the next service. Press ACCEPT to proceed.

If you selected **Reset serial number**, you will see this display:

Message window display	Description
Update serial number	Press ACCEPT to proceed.
Vent serial number xxxxyyzzzz Turn knob to adjust	Turn the knob to set the year of manufacture (the flashing fifth and sixth digits). Press ACCEPT to proceed. NOTE: The first four digits of the serial number are not adjustable. The years 2000 and later are shown as *00*, *01*, etc.
Vent serial number xxxxyyzzzz Turn knob to adjust	Turn the knob to set the next two digits (the flashing seventh and eighth digits). Press ACCEPT to proceed.
Vent serial number xxxxyyzzzz Turn knob to adjust	Turn the knob to set the last two digits (the flashing ninth and tenth digits). Press ACCEPT to proceed.
Serial number OK? xxxxyyzzzz CLEAR (N) ACCEPT (Y)	Press ACCEPT to reset the serial number in NVRAM or CLEAR to return to *Update serial number.*

4.2.4 Review alert log: Reading the alert log

NOTE:
All service functions can be accessed while the ventilator is not ventilating. When ventilating, the only function accessible is the *sensor data* function.

This function lets you read the diagnostic codes in the alert log.

To access this function from the **A.Service menu** prompt, turn the knob until **Review alert log** is displayed.

Message window display	Description
Review alert log	Press ACCEPT to proceed.
Log entries	Review the first entry in the log, referring to Figure 4-7. Turn the knob to scroll through all remaining entries. Press CLEAR to exit.

aa) bbbbb-cc-d eee
date time

where:
- ***aa*** is the error's position in the log (1=the most recently detected)
- ***bbbbb*** is the code number (see Section 4 to interpret)
- ***cc*** is the identifier of the task being run at the time the condition was detected
- ***d*** is the identifier of the subsystem in which the condition was detected
- ***eee*** is the number of consecutive occurrences of the condition
- ***date*** is the month, day, and year the condition was detected
- ***time*** is the hour and minute when the condition was detected

Figure 4-7. Test and alert log format

4.2.5 Test data: Reading the test log or EST test results

NOTE:
All service functions can be accessed while the ventilator is not ventilating. When ventilating, the only function accessible is the *sensor data* function. You can also run EST from the main menu.

This function displays the contents of the test log entries or the EST test results.

To access the *Test data* functions from the **A.Service menu** prompt, turn the knob until **Test data** is displayed, then press ACCEPT. Then turn the knob to locate the desired *Test data* function.

4.2.5.1 Review test log: Reading the test log

This function lets you read the diagnostic codes in the test log.

Message window display	Description
Review test log	Press ACCEPT to proceed.
log entries	Review the first entry in the log, referring to Figure 4-7. Turn the knob to scroll through all remaining entries.

4.2.5.2 Review EST tests: Reading pass/fail status of EST tests

This function lets you read the pass/fail status of all tests during the most recent EST.

Message window display	Description
Review EST tests	Press ACCEPT to proceed.
EST test result	Review the entries in the test log or the individual EST test results, referring to Figure 4-7 (for test log entries) or Section 3.4 (for EST test results). Turn the knob to scroll through remaining entries.

4.3 Utilities functions

4.3.1 Pressure format

This function lets you choose the unit for display of pressures (cmH_2O or hPa).

Message window display	Description
Pressure format	Press ACCEPT to proceed.
cmH2O *or* hPa	Turn the knob to choose either cmH_2O or hPa, then press ACCEPT to select it. The ventilator now runs POST to reset all parameters to the appropriate units.

4.3.2 Date and time format

This function lets you choose the format for display of the date (European or US) and time (12- or 24-hour clock).

Message window display	Description
Date & time format	Press ACCEPT to proceed.
Time format select *or* Date format select	Turn the knob to choose either Time format select or Date format select, then press ACCEPT to proceed. NOTE: Regardless of the selected date format, the years 2000 and later are shown as *00*, *01*, etc.

If you selected **Time format select**, you will see this display:

Message window display	Description
12 hour format *or* 24 hour format	Turn the knob to choose either 12-hour format or 24-hour format, then press ACCEPT to select it.

If you selected **Date format select**, you will see this display:

Message window display	Description
US date format *or* Europe date format	Turn the knob to choose either US date format or Europe date format, then press ACCEPT to select it.